

The Biophysical Modeling of the Apparatuses-stress in the Human Organism

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Abstract: In the last decades the stress concept shifted from the biological doctrine founded by Selye to an integrative psychobiological theory, associated to a biopsychosocial model. The human organism is a biophysical system. Stress represents a normal reaction of the organism which appears as a response to an aggression situation which requires an unusual and quick adaptation effort from the organism. Stress is a state of putting in alert, of mobilizing the forces of the organism in the occasion of an event which requires, in order to be kept under control, a big amount of energy in a very short time. This alert state or action preparation translated through physical and psychological manifestations. In higher-level living organisms the following forms of regulation are known: biological, nervous, hormonal, humoral and immune regulation. In our article we studied all apparatuses-stress in human organism. On middle and long course, the effect of stress elicit about psycho-somatic diseases (hypertension, cardiac and colon problems, etc.) in the general state of health it means disappointment, with drawal from the activity, depression. There are changes also in the social behaviour: conflicts become critical, aggressive actions against others thicken, the tolerance threshold of the individual diminishes.

Key words: stress, negative feedback, digestive-, respiratory-, circulatory-, excretory-, genital apparatus

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I. INTRODUCTION

Living systems are continuously befallen by stimuli from the outer and inner environment and if their intensity exceeds a value or frequency normally acceptable by the organism then it results in the alteration of the oscillatory domain of one or more physiological parameters of the living organism. [1] Consecutively, a given parameter no longer can be kept by its own regulating mechanisms within the normal oscillatory domain. The continuance of such change for a long time entails also a changing process in the structure of the organism. Such status of the living organism is called stress state. [2]

The stress is properly a general adaptational answer rised under the influence of some stressor, with characteristic but not specific changes. The organism can, in general, get along namely by switching on also another regulatory mechanism for the convenient control of the altered physiological parameter. All these surplus regulations need excess-energy from the side of the organism, contribute to wear it and for this very reason accelerate the process, of aging. [3]

In the living organisms stress can be provoked on three levels: on biological, mental and psychical level. We speak of biological level if a physiological parameter gives an overdimens ionated answer to the outer or inner stimulus; e.g. consume a rotten food, contact with an overheated object, effect of a very loud noise, inhalation of spoiled air etc. We speak about mental stress in general during processes bound to learning, acquiring like memorizing, recall, proficiency in speech, be in an examination funk etc. [4] Psychical stress can happen due to impressions related to the (human) personality: sorrow became of the death of a family member, break up the pair relationship, grave slander, uncertainty of existence etc. In man one hardly can rail off sharp limit between these three levels of the stress because the one can influence also the other (second, third) levels and so e.g. it is well known that the long-lasting psychical stress results in biological structural changes. [5]

Every man is a constituent part of a social organ. It is for this very reason not surprising that with man the original reason of stress conditions is his social milieu minimum in 90%.

Regulation

Every living organism is a system. Every living organism system can be defined as a self-regulating system the essential characteristics of which are as follows: its elements possess life as an at- tribute; between its components there is a structural link; the different functional subgroups are informal of each-others' behaviour by communication; the living system has a certain freedom of selection with respect to both the acting trends

and the aims. [6]

The complexity of these essential characteristics of the living systems; is composed of content-component, structural construction, the communication and also the parameters realizing functions ambiguously. [7]

The regulation manifested in the living systems and biological processes which - in spite of external and internal disturbing factors - preserves equipoises (conditions of equilibrium) is called homeostasis. The physiological homeostasis is to keep the inner environment of the living organisms on a relatively constant level. Some physiological processes are able to increase, some others to decrease the various characteristics of the inner environment (pH, concentrations of materials). Against the changes of the outer environment, the appropriate regulating systems start processes of opposite direction this generates the normal (healty) sound homeostasis. [8]

In this state, all physiological parameters characterizing the organism oscillate between a minimum and maximum value. The totality of the dynamic equilibria of the physiological parameters determines the sound condition of the organism. This homeostatic state is maintained by regulatory mechanisms. [9]

It has been discovered in cybernetics that the regulatory mechanisms of the lifeless and living organisms is common and this was called the principle of feedback. In any case once an outgoing feature exert somehow an influence on the ingoing one we speak on feedback. This means that the centre get knowledge how its order has been performed by the executive body (has acted upon the order) then accordingly gives new instruction. [10] This has two possibilities: the so-called negative and positive feedback. In the case of negative feedback, if the value of the outgoing signal is higher it sets up the decrease of the functional action (of the device) if in turn it is lower it brings about the increase of the functional intensity. In the case of positive feedback, if the value of the outgoing sign is higher or lower, resp. it entails further increase or decrease, resp. Because the task of the regulation is to keep the living system on the prescribed value despite outer disturbances, it's evident that very regulation is a negative feedback.

The negative inverse connection functions "constantly" and its main role is, to maintain certain functional parameters of the body to a relatively constant value. This is about a relative stability, since the adjustment involves oscillations around an abstract medium value with a tendency to minimize the deviation in respect of this mean value. [11]

Let's denote with $\mathbf{o}(\mathbf{t})$ the exit output and the mean value of the characteristic parameter on the system is $\mathbf{o}^*(\mathbf{t})$; after the adjustment, the values of the outputs obtained shall be denoted with

$$\mathbf{o}(\mathbf{t}_1), \mathbf{o}(\mathbf{t}_2), \mathbf{o}(\mathbf{t}_3), \dots, \mathbf{o}(\mathbf{t}_n) = \mathbf{o}^*(\mathbf{t});$$

$$\text{if } \mathbf{t}_1 < \mathbf{t}_2 < \mathbf{t}_3 < \dots < \mathbf{t}_n.$$

We talk about a negative inverse value, if the following two conditions are satisfied:

$$|\mathbf{o}^*(\mathbf{t}) - \mathbf{o}(\mathbf{t}_1)| > |\mathbf{o}^*(\mathbf{t}) - \mathbf{o}(\mathbf{t}_2)| > |\mathbf{o}^*(\mathbf{t}) - \mathbf{o}(\mathbf{t}_3)| > \dots > |\mathbf{o}^*(\mathbf{t}) - \mathbf{o}(\mathbf{t}_n)|$$

$$\frac{d|\mathbf{o}(t_i) - \mathbf{o}^*(t)|}{dt} \leq 0.$$

In the living organisms, all the mechanisms for maintaining a constant composition and internal environment function on the basis of on negative feedback.

The stress of the digestive apparatus

The provocation of the gastric ulcerations through experimental stress represented one of the first contributions of Selye. These observations have been extended a lot and the provocation of peptic ulcer became a classic model of stress. [12]

Oesophageal ulcer appears in the terminal part of the oesophagus, due to the erosive action of the hyperacid gastric secretion regurgitated from the stomach in certain morphofunctional conditions. Gastric ulcer is a lesion of the stomach characterized by a substance loss of the gastric mucosa, most times in the small curve or at the entry and it manifests clinically through a painful epigastric and dyspeptic syndrome with food rhythmicity and seasonal periodic evolution. [13]

In human pathology the relation between the ulcerous disease and the stressing psycho-physiological factors is widely discussed in the psychosomatic field starting with Alexander's psychodynamic theory and Kurtin's and Bicov's cortical visceral therapy, with psycho-physiological touch. Unlike the experiment in which gastric ulcerations are produced rather rapidly and they cannot be identified with the human ulcerous disease, the relationship between stress and ulcerous disease implies the identification of some chronic stressing factors. [14]

Feldman and colab., highlighted some features, especially hypochondria, a negative perception of the life events, addiction, which distinguishes the ulcerous men from the non ulcerous ones; we can conclude that this is a firm association between the critical events, the features and the psychological factors and the ulcerous

disease. According to Theorell, except for the critical events, the occupational factors, especially the reduced decision possibilities increase the incidence of hospitalization for ulcerous disease. In conclusion, stress and some personality features represent factors which must be included in the complex genesis mechanism of the ulcerous disease.

Diarrhoea is an abnormal emptying of the intestine, characterized by more or less watery frequent bowel movements. [15]

Colitis. This is a generic name for the inflammation of colon. The acute colitis, a localized or diffuse affection of the large intestine, with infective character, parasitary or toxic, appearing suddenly and lasting for a limited period of time. The chronic colitis is an inflammatory and dystrophic process, localized and extended, of the large intestine, of unknown cause (infective colitis, parasitary or toxic) or imprecise (ulcerous colitis, mucomembranose colitis), evolving continuously or in accesses over long periods of time. The dysenteric colitis, colitis caused by an infection with the dysenteric bacilli, characterized by ulcerative lesions of the colic mucosa, followed by haemorrhages.

The stress of the respiratory system

Asthma is a pathological state in which there is an intense need for air, its eviction from the lungs being made difficultly. [18]

The bronchial asthma is caused by a bronchospasm with allergic, neurogene pathology, characterized by paroxystic expiration dyspnoea (determined by the bronchial obstruction through oedema, hyper secretion, spasm and mucus tap), cough with pearly expectoration (containing eosinophilic cells, Charcot-Leyden crystals and Curschmann spirals), bronchial rhonchi, cardio-circulation disturbances. [17]

The general influences and manifestations of stress

<p>1. Influences on the personality Agitation, aggression, apathy, depression, fatigue, disillusion, guilt feelings, irritability, psychic tension, negative autoevaluation, nervousness, alienation</p>	<p>2. Influences on the behaviour Vulnerability to incidents, alcohol and narcotics addiction, emotional crisis, bulimia or anorexia, excessive smocking, impulsive behaviour, tremor</p>
<p>3. Cognitive effects Incapacity to make decisions, lack of concentration, amnesia, hypersensitivity to critiques, inhibition / mental blocking</p>	<p>4. Physiological effects Increased levels of CA in the blood, hyperglycaemia, tachycardia, increased BP, dry mouth, hyper sweating, mydriasis, dyspnoea and hyperventilation, waves of hotness and coldness, tingling in the extremities</p>
<p>5. Influences on the health Thoracic and dorsal pain, diarrhoea, vertigo and faint, frequent urination, headaches and migraines, insomnias, nightmares, impotence, amenorrhea, proper psychosomatic diseases</p>	<p>6. Influences on the work capacity Lack of concentration, workplace conflicts, decreased productivity, frequent professional incidents, dissatisfaction, instability / fluctuation</p>

where: CA – catecholamines; BP – blood pressure

Cardiac asthma is an average clinic form of manifestation of the acute left ventricular insufficiency characterized especially by a crisis of paroxysmal dyspnoea, with sudden debut, sometimes at night and usually not joined by other functional or physical signs. Dyspeptic asthma is a bronchial asthma caused or maintained by a digestive irritation spine. Pollen asthma is a bronchial asthma whose allergen is represented by pollen; it is characterized by ocular nasal laryngeal secretomotor manifestations: tearing, rebel sneeze, nasal hydrorrhoea, expiratory dyspnoea, cough with sieromucous dyspnoea. Professional asthma is a bronchial asthma caused by the sensitivity towards a substance manipulated during the professional activity. [18]

Hypoventilation is a reduced ventilation. Alveolar hypoventilation is a functional syndrome, characterized by alveolar air stasis (increase of the residual volume) and found in the emphysema, asthma, kyphoscoliosis etc. It is the cause of the global respiratory insufficiency with hypoxia and hypercapnia. The

pulmonary hypoventilation is a functional syndrome characterized by the decrease of the pulmonary ventilation flow. The global pulmonary hypoventilation is caused by the disturbance of the central nervous adjustment of the respiration, the obstruction of the upper air ways and it determines the global respiratory insufficiency; partial hypoventilation, more frequent is found in various thorax - diaphragm disturbances and pleural-pulmonary and it causes partial respiratory insufficiency.

Hyperventilation, is a pulmonary ventilation unproportionally big compared to the oxygen intake; the use coefficient of oxygen is lower, the ventilation equivalent of O₂ and the respiratory coefficient are bigger than normal. The functional pulmonary syndrome, characterized by the increase of the ventilating flow is the expression of nervous coordination disturbances or it is due especially to a compensating mechanism in the respiratory insufficiency (ischemic anoxic, hystonic and anaemic); it can correct the deficit or not, if it coexists or not with an alveolar hypoventilation.

Stress manifestation in the circulatory apparatus

The cardiovascular system has a major role in the biopsyo-social reaction of the human organism. This problem is important considering the concerning incidence of cardiovascular disease at global level, mainly due to stress. [19]

This problem is of main interest. Stress, especially the one with negative influences (distress) became a component of the contemporary life. The integrated and correlated interests involved in the cardiovascular adaptation imply central cortical commands (cerebral cardiorespiratory neurons), hypothalamic, the sympathetic and parasympathetic nervous system exerted on the heart (cardiac frequency, systolic flow, cardiac flow) and the vascular system (arteries, capillaries, veins). [20] There are particularities as well: hence, local factors of autoadjustments of the blood flow, of the cerebellum and brain stem interfere in the physical effort, elements which influence the motor system. [21]

Stress cardiomyopathy is a disease caused by an intense emotional or physical stress leading to reversible, rapid or severe cardiac dysfunction. They mimic a myocardic heart attack. Some authors sustain that watching a stressing football game doubles the risk of an acute cardiovascular event. [22]

Various papers intend to relate the individual personality and behaviour characteristics with the stress susceptibility and the cardiovascular diseases. Most of these papers follow the A and B typology, some studies prove the increase vulnerability to the coronary disease of the subjects belonging to type A. Currently the type A personality is considered as being prone to psychosomatic disease and not exclusively for the coronary disease. [23]

Stress affects the peripheral hemodynamic through effects depending on its intensity: light stress reduces the peripheral resistance through the activation of the vascular receptors **B**, and the intense stress increases the peripheral resistance and the diastolic arterial pressure through the receptors **α**.

The stress system included several neuroendocrine subsystems. A key role comes to the hypothalamic pituitary adrenal axis which assures the secretion of the stress hormone – cortisol and on the other side the adrenal medullar system with the secretion of the catecholamines (adrenalin and noradrenalin). Both systems assure the mobility related reflexes, mobilize cognition and attention and stimulate the cardiovascular and metabolic functions under stress conditions. [24]

Stress manifestation in the excretory apparatus

The urination is a physiological act of elimination of urine on natural ways. The imperious urination sensation, the impossibility to retain the urine for a longer period of time from the moment of feeling the need of urinate denotes a sufferance of the vesical tube and the impossibility of the wrinkled sphincter or perineal muscle to oppose to the urine emission. [25]

The sweat is the secretion and the passing to the glands and other tegument formations of the water vapours, carbon dioxide of some salts and inorganic substances, which all together form sweat.

The name of nephritis was used in the past to denote a bilateral acute or chronic, inflammatory or degenerating, renal disease; currently it is used only referring to the interstitial nephropathy, in the experimental models of nephropathy or, occasionally for unknown or uncertain nephropathies. [26]

The information regarding the urinary elimination of metabolites of catecholamines is more numerous, especially vanillylmandelic acid which represents a considerable amount (20–80%) of the products from the degradation of catecholamines. The eliminations of 17-ketosteroids served more as the main criteria for the appreciation of the cortical-adrenal gland to solicitations.

The manifestation of stress in the genital apparatus

There are few people who at times of crisis become creative and follow the normal course of things. We are affected by the things around us and this is obvious even when we try to utter a few words. We almost

cannot even mention an erection, not even as a joke. So the dysfunction of the sexual apparatus, both in case of female frigidity, and male impotence, is due in general to factors such as stress. [27]

Erectile dysfunction in men is not limited to the inability to have a penile erection. Also called impotence, the erectile dysfunction can describe additionally the problems that a person can have with the dimension, the rigidity and the duration of erection, the most obvious symptom of impotence is the man's impossibility to copulate, through the lack of erection. While others can mistake the exact definition of the erectile dysfunction, in the sense of associating it with the lack of willingness to have sexual intercourse and with problems related to reaching orgasm and ejaculating, it is not always correct or applicable. When impotence is defined in medical terms, it is limited to the inability of a man to have or to maintain an erection long enough to have satisfying sexual intercourse. The impotence becomes more common once the men start to age. There is a sequence of complex phenomena happening in the body for the man to have an erection.

Regularly, the erection is an involuntary act of the body. The impotence produces only when the man cannot finalize successfully a sequence of sex related events or any other type of sexual activities. The most frequently found cause of impotence which affect men is the reduced blood circulation towards the penis and lesions of the nerves that the person has suffered in the past. Regardless of the cause, physiological or psychological, the impotence can affect not only the man confronting with erectile dysfunction, but also its life partner. When a man suffers of impotence, this thing does not affect only his sexual life, but his entire life and spirit. Except for the main causes of impotence, feeling of mistrust, stress and anxiety can contribute to the extent they manifest, feeding it continuously. [28]

There are several risk factors which can lead to the impotence of a man. Age is a risk which cannot be avoided. It is been estimated that approximately 80% of the man over 75 deal with impotence. Also a chronic medical affection can lead to impotence or erectile dysfunction if it affects any of the normal penile processes, such as the blood flow.

Widely, frigidity means the weakness or the absence of sexual desire (libido) and also the capacity to feel naturally pleasure during the sexual intercourse. Clinically, the term of frigidity is used to denote the woman's incapacity to reach orgasm. In general terms, frigidity is known as the low libido or even lack of libido, in women, so the frigidity is an indifference or aversion towards sexual intercourse, due to the lack of orgasm.

Frigidity can be due to anatomical-physiological causes or to psychological causes, or a combination of them. We must understand that our psychic law is not limited to the conscious, but there are deeper levels (unconscious, subconscious) which are as active as the conscious and interact permanently with it. Hence, frigidity can appear as a consequence of crank, respectively the process through which certain images, ideas, tendencies of unpleasant desires for that person or which are against the moral norms are removed from the conscience, from where they have the permanent tendency to come out to surface. Another situation which can cause frigidity is the one where in the couple exists a permanent discontentment state. Also, frigidity can be manifested as a real defence method that the organism uses against the „enemy” when that women is very afraid of a possible pregnancy.

Generally, the physical problems which lead to the decrease or disappearance of the libido are: pain or discomfort during sexual intercourse; insufficient lubrication of the genital area; the lack of an adequate prelude; the unsatisfying performance of the partner; exhaustion or tiredness states; insomnia; medicines, alcohol or drugs effects; changes due to menopause or hormonal unbalance; lesions of the nerves caused by surgical interventions or traumas, infection or other gynaecological problems. [29]

Generally, a poor libido or its lack can be caused by traumatising sexual experiences from the past such as rape, incest or other forms of sexual aggression; emotional impossibility towards the life partner as well as communication problems in couple; the feeling of repulsion towards the sexual act. This thing can be due to: shame, depression anxiety feeling or even the monotony feelings; situation factors, such as high, drunk partners or the development of the sexual act in the same house with other people (such as parents, sisters, in-laws, etc); the fear of getting pregnant or contracting sexually transmitted diseases. [30]

In certain cases, due to the poor libido, women can refuse or avoid sexual contact, or they can undergo it without feeling any type of pleasure and without reaching orgasm. In other cases women can have difficulties about sexual excitation, this thing leading to a feeling of discomfort or even pain during intercourse. Regardless of the cause and „symptoms”, frigidity leads most of the times to conflicts between partners. It is important to know that there are solutions which can make frigidity disappear and the things to go back to normal.

Therefore, we must observe that the most frequent factor of impotence and frigidity is stress. The temporary removal of stress generally normalized the dysfunction of the sexual apparatus both in most men and most women.

II. SUMMARY

Selye published his famous theory of the stress in *Nature* in 1936. [31] For the stress motto is the inscription at the main entrance of the Institute of Experimental Medicine and Surgery (Montreal): “Neither the prestige of your subject, and the power of your instruments, nor the extent of your learnedness and the precision of your planning, can substitute for the originality of your approach and the keenness of your observation.” The stress in the human organism is a perturbation. This perturbation is regulated by negative feedback. The modeling method in biophysics consists of the creation of certain devices (models), with which processes analogue with those happening in living organism are studied. The biophysical model through abstract reasoning leads to models of the phenomena which by simplifying and isolating some aspects of the phenomena discover laws and relationships which describe with a certain approximation the behaviour or functioning of bodies or biological ensembles. [32]

By means of our biological endowments and in consequence of nowadays medical technics man could have lived 120 years but the stress conditions affecting us during our life shorten it by more decades. The secret of longer lifetime is to avoid stress conditions because it yields the accumulation of an inner surplus energy and lessens the wear and tear of the organism originating from the normal physiological processes. [33, 34]

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